F·A·A·M facility for airborne atmospheric measurements

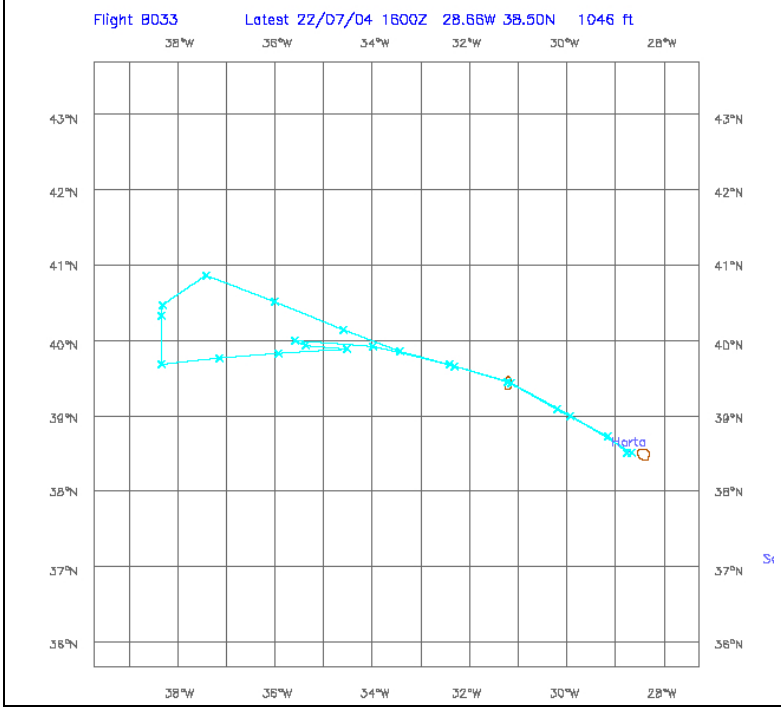
FLIGHT FOLDER

Flight No.:	B033
Date:	22 Jul 2004
Take Off	10:51:13
Landing:	16:01:26
Flight Time	5h10m13

Trials Instructions: ITOP – Interception of North American pollution, characterisation of background atmosphere and ENVISAT validation.
Operating Area: West of Azores

POB	Position	Name	Institute
1	Captain	Alan Foster	Directflight
2	Co-pilot	Alan Roberts	Directflight
3	Mission Scientist 1	Steve Arnold	Leeds University
4	Flight Manager	Steve Devereau	FAAM
5	Core Chemistry/FWVS/CCM2	Doug Anderson	FAAM
6	HCHO	Graham Mills	UEA
7	PTR-MS	Anne Hulse	UEA
8	WAS	Nicola Watson	York University
9	PERCA	Alex Parker	Leicester University
10	Peroxides	Brian Bandy	UEA
11	AMS	Paul Williams	UMIST
12	NOxy	Dave Stewart	UEA
13	Mission Scientist 2	John Methven	Reading University
14	Mission Scientist 3	Ally Lewis	York University
15	PAN/TDL	James Lee	York University
16	CCM	Gaynor Ottaway	Directflight
17			
18			

Flight Track:

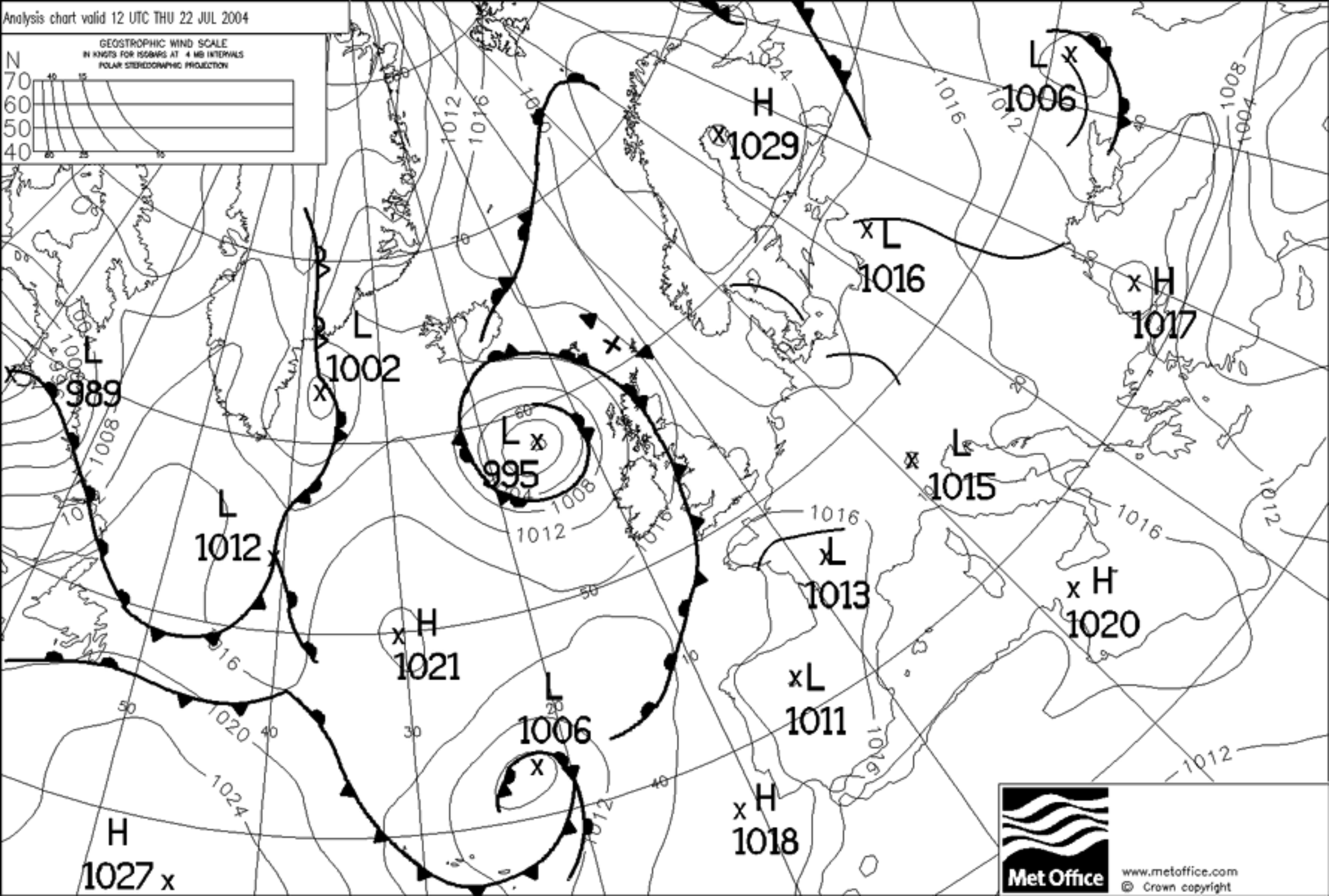


FLIGHT SUMMARY

Flight No B033
Date: 22/07/2004
Project: ITOP
Location: Horta, Azores

Start Time	End Time	Event	Height (s)	Hdg	Comments
104437		Taxi			PSAP flow off
105113		T/O	0.00 kft	270	
105518	105756	Run 1	5.0 kft	338	
105750					JW cals complete
105916		EVM	6.0 kft	298	PSAP flow on
110329	120257	Run 2	10.0 kft	299	
111829		EVM	10.0 kft	300	PSAP rack not on, now powered up
112210		EVM	10.0 kft	301	NOxy cal complete
113900					start video recording
115800					SATCOM call, CCM to DFL
120440	122231	Profile 1	10.0 - 26.0 kft	298	
122342	125011	Run 3	26.0 kft	290	
122631		EVM	26.0 kft	289	Core Chem cal finishd
122735					TWC reset
125218	130943	Profile 2.1	26.0 - 5.0 kft	207	2500 ft/min
130000					SATCOM call, CCM to DFL
130007		interrupt P 2.1	15.5 kft	205	
130205		recommence P 2.1	15.5 kft	013	
131728	132724	Profile 2.2	5.0 - 0.10 kft	200	500 ft/min
132200		EVM			ship plume?
132921	133922	Run 4	0.10 kft	089	
133929	134425	Profile 3	0.10 - 3.0 kft	075	
134119					PSAP flow off
134302		EVM	1.8 kft	080	cloud line
134529	135530	Run 5	3.0 kft	076	
134620					PSAP flow on
135552	140056	Profile 4.1	3.0 - 5.0 kft	078	500 ft min
140056	140714	Profile 4.2	5.0 - 11.0 kft	079	1000ft/min
140730	141731	Run 6	11.0 kft	079	
141917	142437	Profile 5	11.0 - 16.0 kft	282	
142447	143420	Run 7	16.0 kft	275	
143420	143932	Profile 6	16.0 - 21.0 kft	274	
144153	145154	Run 8	21.0 kft	088	
145154	150211	Profile 7	21.0 - 9.1 kft	089	
150331	154534	Run 9	9.0 kft	098	
150802		EVM	9.0 kft	095	Core Chem cal finishd
152151		EVM	9.0 kft	096	NOxy cal finished
160000					PSAP flow off
160126		Land	0.09 kft	270	

160525 GPS final position 38.31.26N 28 42.98W
160600 INU final position 38 30.70N 28 41.93W


Analysis chart valid 12 UTC THU 22 JUL 2004
GEOSTROPHIC WIND SCALE
IN KNOTS FOR ISOBARS AT 4 MB INTERVALS
POLAR STEREOGRAPHIC PROJECTION
N
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995
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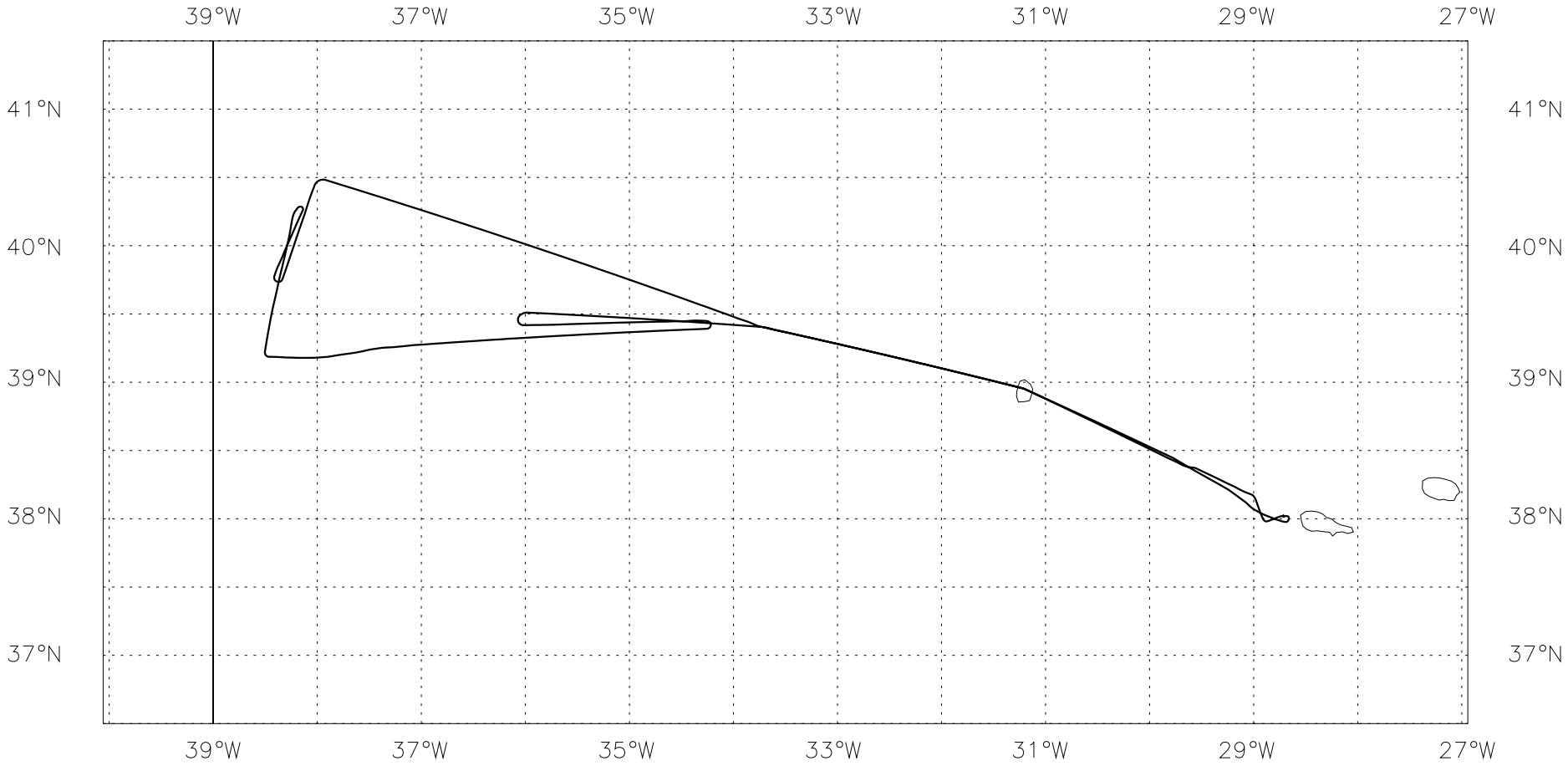
B033 Track 22-JUL-04



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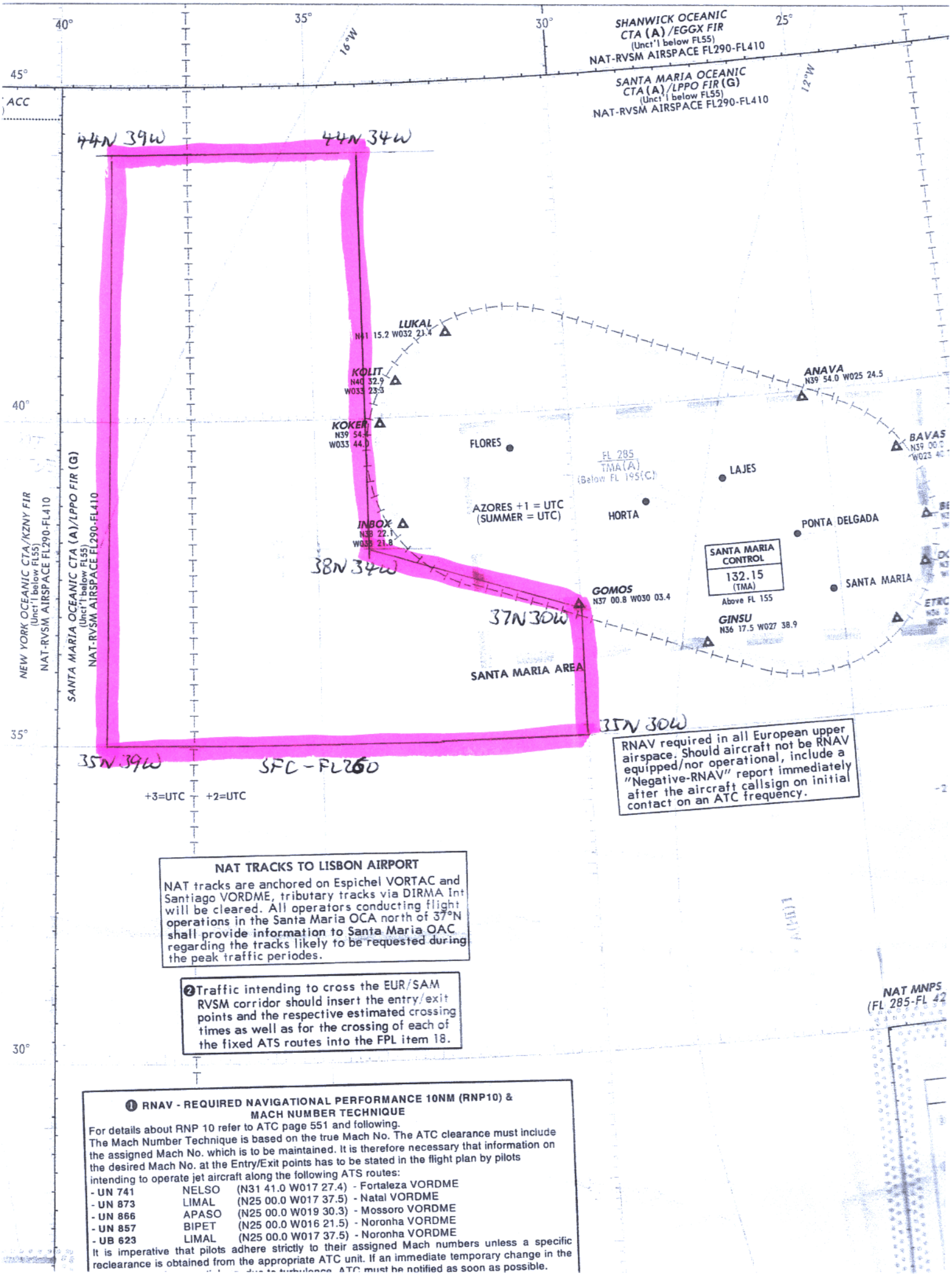

RNAV required in all European upper airspace. Should aircraft not be RNAV equipped/nor operational, include a "Negative-RNAV" report immediately after the aircraft callsign on initial contact on an ATC frequency.

NAT TRACKS TO LISBON AIRPORT

NAT tracks are anchored on Espichel VORTAC and Santiago VORDME, tributary tracks via DIRMA Int will be cleared. All operators conducting flight operations in the Santa Maria OCA north of 37°N shall provide information to Santa Maria OAC regarding the tracks likely to be requested during the peak traffic periodes.

❷ Traffic intending to cross the EUR/SAM RVSM corridor should insert the entry/exit points and the respective estimated crossing times as well as for the crossing of each of the fixed ATS routes into the FPL item 18.

❶ RNAV - REQUIRED NAVIGATIONAL PERFORMANCE 10NM (RNP10) & MACH NUMBER TECHNIQUE

For details about RNP 10 refer to ATC page 551 and following.
The Mach Number Technique is based on the true Mach No. The ATC clearance must include the assigned Mach No. which is to be maintained. It is therefore necessary that information on the desired Mach No. at the Entry/Exit points has to be stated in the flight plan by pilots intending to operate jet aircraft along the following ATS routes:

- UN 741	NELSO	(N31 41.0 W017 27.4) - Fortaleza VORDME
- UN 873	LIMAL	(N25 00.0 W017 37.5) - Natal VORDME
- UN 866	APASO	(N25 00.0 W019 30.3) - Mossoro VORDME
- UN 857	BIPET	(N25 00.0 W016 21.5) - Noronha VORDME
- UB 623	LIMAL	(N25 00.0 W017 37.5) - Noronha VORDME

It is imperative that pilots adhere strictly to their assigned Mach numbers unless a specific reclearance is obtained from the appropriate ATC unit. If an immediate temporary change in the

B033: ITOP – Interception of North American pollution, characterisation of background atmosphere and ENVISAT validation.

Mission Scientists: Steve Arnold & John Methven

Date: 22/07/04

Outline schedule:
07:00 UT - Power to aircraft - Warm-up
09:00 UT - Air Crew Briefing
10:15 UT – Security sweep
10:30 UT – Boarding deadline
11:00 UT - Take-off

Location: West of Azores

Aim: To intercept a layer of polluted air near Azores at around FL100, which is due to pass over France on 24-25/07/04. Profiles through the depth of the operating region will be made to characterise air above and below polluted layers. A stepped deep profile in the west of the operating region will be made to coincide with the location and time of an ENVISAT overpass between 13:01 and 13:02 UT.

Sortie Detail

1. T+0 Take Off. Ascend to first available level for wet chemistry checks. (10)
2. T+10 Ascend to FL100 and transit directly to edge of operating region (34W) via Koker. Include at least 20 mins level in clear air for cals. (65)
3. T+75 Profile ascend to FL260 into satellite swath (20).
4. T+95 Continue on same heading further into satellite swath looking for cloud-free region. (15)
5. T+110 Turn southwards and profile descend to 100ft (@ 1500 ft/min) in stepped pattern along swath of satellite pass (@13:01:30) (20)
6. T +130 Turn onto heading for route to Koker. Level run @ 100ft (20).
7. T+150 Profile ascent to FL260 (1000 ft/min), interrupted by level runs of 10 mins each on two levels to be determined in flight. (45)
8. T+195 Profile descend to FL110 for exit via Koker. (20)
9. T+215 Leave operating region and transit back to Horta. (75)
10. T+290 Land.

Flight B033 22nd July 2004 Report

The aims of the flight were: a) to intercept a layer of polluted air of North American origin, which the forecast showed to be lying almost directly overhead Horta, stretching out to the west, and which was forecast to be advected onto France in subsequent days; b) to characterise the background chemical profile of the North Atlantic outside of the layers of pollution, which had been ubiquitous in ITOP flights to date; c) to make a deep profile descent coincident with the position and time of an ENVISAT overpass between 13:01 and 13:02 UT.

The submitted flight plan was adhered to, with a transit from Horta to Koker via Flores at FL100, the forecast altitude of the North American air close to the Azores. At Koker, we entered our operating region where we continued on our heading, and climbed to FL260 into the region of the ENVISAT overpass swath. A profiled zig-zag descent was then made along the axis of the swath, with the satellite passing overhead midway through the profile. Following this, a level run at 100f t, and a second deep profile upwards from 100ft, were made, interrupted by level runs at several different altitudes.

The first level run enroute to Koker at FL100 was noted to be slightly above the targeted pollution layer, which was actually intersected on the climb out of Horta between 8500 and 9500ft. However, the layer was occasionally sampled, as the aircraft skimmed along the upper boundary of it. The layer was characterised by elevated ozone (~80ppbv) and CO (80-100 ppbv), and was drier than the surrounding air. NOx concentrations were also elevated when sampling the layer. Increases in sulfate aerosol were also noted in the drier polluted air.

Profile 1 sampled air between FL100 and FL260, heading towards the satellite rendezvous. Just above FL100, a thin layer of enhanced CO (110 ppbv) was intersected, as part of the target layer believed to be going onto Europe. Above FL110, a more moist layer was sampled with lower CO and ozone. The NO_2 channel failed due to low pressure at 13500ft. A broad layer of lower relative humidity (< 70%) and elevated ozone (75-90 ppbv) was sampled between FL170 and FL250. CO concentrations in this layer varied little between 65 and 75 ppbv. Elevated concentrations of acetone, acetaldehyde, RO_2 and HCHO were noted in the layer, showing possible evidence for continued ‘trickle-down’ processing in the aged air.

At the waypoint 40.4N, 35.4W Profile 2 was started along the axis of the ENVISAT swath in a zig-zag profile. The initial descent leg under the ENVISAT pass was made to FL155 at 1500 ft/min, which intersected the dry, ozone rich polluted layer between FL230 and FL155. A reciprocal descent was then made down to 5000 ft at 1500ft/min. A more moist layer of moderately elevated CO/ozone (70-85pbbv) was sampled, before entering a layer of ~90% relative humidity and very low ozone (15-25ppbv) below 6000ft. Descent down to 2500ft was continued at 500ft/min, followed by a reciprocal descent to 100ft. The local PBL was noted at ~1100ft, which showed a sharp increase in CO and some very low ozone concentrations (10-15 ppbv).

A series of level runs at various levels were made in an east-west orientation between ~36W and 34W. A 10-minute level run at 100ft was made, during which a ship plume was noted south of a cargo vessel, by a sharp increase in NOx. This was followed by a

profile ascent to 3000ft, in order to sample the layer of low ozone and high relative humidity. A level run eastwards at 3000ft (R5) sampled air with reduced, but slightly higher ozone concentrations (30-45ppbv) than those observed during the profile descent. The latter part of the run entered more polluted air on the same vertical level, with CO concentrations between 80 and 90 ppbv. This layer extended vertically to ~FL80, during a profile ascent to FL110.

A level run (R6) eastwards at FL110 showed a similar air mass structure, as more polluted air was encountered towards the eastern end of the run, with the top of the polluted layer encountered at about FL120 during ascent. A level run westward at FL160 encountered a maximum of 90ppbv ozone in the polluted air mass, with associated increases in acetaldehyde and formaldehyde. These enhancements reduced as the aircraft moved westwards away from the pollution. A profile ascent to FL210 encountered a narrow polluted layer at FL200, with ozone concentrations up to ~90ppbv. This air mass was again encountered further east at a slightly higher altitude, on a level run at FL210 (R8).

A descent was then made to FL090, in order to pass through the North American layer close to the Azores at a slightly lower altitude. The upper level, dry, polluted layer was seen to extend down to FL160, below which, a more moist layer of lower ozone concentrations, anti-correlated with water and relatively invariable CO (~65 ppbv) was encountered, down to FL130. At FL120, the top of the lower level polluted layer was crossed, which lay on top of a less polluted, more moist layer down to FL90. Polluted enhancements sampled on the level run at FL90 were not as large as those intercepted in the narrow layer at FL120, and the main layer was only encountered on the final descent into Horta at ~6000ft, with CO concentrations up to ~130ppbv.

26000

15500

5000

2500

Aircraft Scientist's Log

Flight No **B**.033..... Date 22/07/04 Page 1 of 3

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GMT	Run / Profile	Height	Hdg	GPS Position	Remarks (clouds, weather, visibility, winds, sea state etc.)
11:02:28 12:02:57	R2	FL100	300		O_3 60 - 80 ppbv CO 80 - 90 ppbv ~ level
					O_3 / CO sharp drop ~ 11:14 UT
					Crossed moderately polluted layer
					@ 9000 ft. => Skirted along
					top @ FL10 between 11:18 - 11:19
					* Return @ FL9 rather than FL11??
					11:18 - 11:25 CO v. flat
					~ 90 ppbv
					Slow increase to CO with decrease
					in O_3 Slow decrease to O_3 with
					constant CO. Water / O_3 anticorrel.
					11:29:30 increase to O_3 / decrease water.
					small increase in CO. 60 - 70 ppbv
					Sharp gradient 11:31. After passing
					through same concs. as in layer
					sampled on climb. → Direct over Flores.
					NO_x increase in drier, higher O_3 air.
					11:15 - 11:53 increase in SO_4^{2-}
					aerosol. Lower O_3 / moister. Correlated with
					PTRMS - steady concs higher O_3.
					→ not particularly polluted.
12:07:38 12:22:30	P1	FL100 FL260	300		Re-entered polluted layer at start of profile
					Above 11 000ft moister, lower O_3/CO layer.
					NO_2 channel problems above 13500ft.
					Narrow layer CO ~ 85 ppbv @13500ft
					Drier layer - correlated O_3/CO 16-17000ft

Aircraft Scientist's Log

3000ft
11 000ft
16000ft

Flight No B...033.... Date ...22/07/04..... Page 2 of 3

FAAM © 2004

GMT	Run / Profile	Height	Hdg	GPS Position	Remarks (clouds, weather, visibility, winds, sea state etc.)
					Anticorrel O_3/CO, dry layer 17200 ~~Higher acetonitrile / HCHO~~
					PAN 0.3 - 0.4 ppbv
					O_3 / water anticorrel. Thro layer
					with constant CO. some evidence of trickle-down to
					HCHO thro oxygenates? ⇒ evidence of elevated acetaldehyde
12:23:40	R3	FL260	290		Top layer, CO ~ 75ppbv O_3 60ppbv
					~ 40% RH
12:52:17 13:00:06	P2-1	FL260 FL155	205		1500 ft/min
13:02:04 13:09:41	R2&2	FL155 FL50	025		Cleaner layer 14500ft. CO 70ppbv O_3 78ppbv
13:17:27 13:27:35	P2-2	5000ft 2500ft			V. moist low O_3 (20ppbv) layer 7000 - 5000
		~~2000ft~~			500ft/min descending thro layer of V- Low O_3 15-20 ppbv. Constant CO
					75ppbv. PBL transition ~ 1700ft??
13:29:26 13:39:23	R4	100ft			Ship plume?? Hi NOx 13:30
13:39:23 13:44:24	P3	100ft -3000ft			500ft/min. N38°43' Precip @ 13:42:36 W 37°18.2' Line of cloud.
					Local PBL top ~ 11000ft
13:55:28	R5	3000ft			O_3 35 - 45 ppbv CO ~ 75ppbv
13:55:52	P4	3000ft - FL110			
14:07:30 14:17:30	R6	FL110			CO cat giving low O_3 ~ 14:08 CO level 75-80ppbv. O_3 50-60 ppbv.
14:19:17 14:26:35	P5	FL110 - FL160			Into layer of drier higher O_3/CO
					Thro thro low O_3/CO directly above.
					12000 - 13000ft 50-60 ppbv ~ 60 ppbv
					Sharp gradient @ 12000ft between higher CO below. 80 → 60 ppbv
14:26:47 14:34:20	R7	FL160			O_3 up to 80 ppbv. Acetaldehyde/HC increase.
14:34:20 14:39:20	P6	FL160 FL210			Enhanced O_3 layer @ ~ 20 000ft
					90 ppbv.

Aircraft Scientist's Log

Flight No **B** 033 Date 22/07/04 Page 3 of 3

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GMT	Run / Profile	Height	Hdg	GPS Position	Remarks (clouds, weather, visibility, winds, sea state etc.)
14:41:50 14:51:52	R8	FL210			Higher O_3 ~ 90 ppbv. CO level ~70 ppbv
14:51:52 15:02:10	P7	FL210. FL90			16500 – 13000ft Drop in O_3 95–50 ppbv.
					CO ~ constant @ ~ 60–65 ppbv
					sharp transition to CO ~90 ppbv
					O_3 8'00 ppbv @ 11 000ft.
					Acetaldehyde ↓ Acetone ↑
					1501 highest SO_4^{2-} aerosol. + peroxide ~100 ppbv CO
15:03:31 15:45:34	R9				Moist Low O_3 ↗ 40 ppbv @ 15:31 CO ~70 ppbv

CORE CHEMISTRY FLIGHT LOG

FLIGHT: B033	DATE: 22/07/2004	OPERATOR: Doug Anderson	PAGE: 1 of 1
LOCATION: West of the Azores		PROJECT: ITOP - Interception of processed North American pollution, characterisation of background atmosphere and ENVISAT validation.	

GAS CYLINDER PRESSURES	N2	Argon/CO2	CO
PRE FLIGHT	psi / bar	psi / bar	psi / bar
POST FLIGHT	15 psi / 1 bar	48 psi / 3.3 bar	900 psi / 60 bar

TIME (GMT)	HEIGHT (Flight Level)	RUN #	CO SENSITIVITY (Hz/ppbV)	CO BACKGROUND (ppb)	CO BCKGRD.CNT.B (Hz)	CO CONC. (ppb V)	O3 ( )	NO (ppb)	NO2 (ppb)	NOx (ppb)	SO2 (ppb)
/07/04 :	?	?				-	-	-	-	-	-
	Remarks: last calibration data from previous flight for comparison with today.										
10:58:43	5000' ^	R1	87.09	69.60	6061.13	101.750	60-24	-	-	-	-
	Remarks: Nox box and CO cal started @ 5000'. During cal aircraft began climb and O3 value fell. Monocr: 0.96, Cal gas: 2.41 CO cal ended: 11:01:10										
11:04:20	FL100	R2	86.81	69.44	6028.26	61.424	54	-0.08	0.24	0.16	-
	Remarks: Level run. O3 value 24 during Nox cal. O3 back to 54 by 11:08:03. Cal ended: 11:06:45										
12:23:15	FL260	R3	95.74	61.87	5923.51	62.535	63	0.14	0.13		-
	Remarks: O3 dropped from 66 to 30 during NOX cal. Cal ended: 12:25:38 when O3 returned to 63										
13:27:30	100'	Turn	102.3	60.23	6161.70	69.366	18	0.12	0.10	0.22	-
	Remarks: O3: 19->12 during cal. Cal run during banked turn and height varied by a couple of hundred feet. Cal ended: 13:29:49										
13:30:50	100'	R4	102.73	60.18	6182.30	66.595	19	-0.13	0.14	0.00	-
	Remarks: Second cal due to turn altitude change during previous cal.										
13:44:55	3000'	Pre R5	101.95	59.93	6109.93	72.103	32	-0.11	0.23	0.12	-
	Remarks: R5 started 13:45:29. Cal ended 13:47:20										
14:07:30	FL110	R6	101.06	59.33	5995.84	75.973	57	-0.15	0.06	-0.09	-
	Remarks: Cal started on "start of run" call. No Nox cal so no drop in O3. However, O3 may still be affected by CO cal due to altered pipe work. Cal ended: 14:09:55										
14:25:28	FL160	R7	101.29	58.35	5910.50	57.938	90	-0.12	0.12	-0.01	-
	Remarks: No Nox cal so no drop in O3. However, O3 may still be affected by CO cal due to altered pipe work. Cal ended: 14:27:53										
14:41:53	FL210	R8	101.36	57.49	5826.68	63.564	87	0.12	0.03	0.14	-
	Remarks: CO only cal. O3 varied between 77 & 85 (77 during cleaning section)										
15:04:28	FL090	R9	102.67	58.28	5983.94	101.799	67	0.02	0.09	0.10	-
	Remarks: Cal at same time as other instruments. Cal ended: 15:06:50 TECO Nox cal at same time; O3 range: 35-53										
	Remarks:										
	Remarks:										
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FWVS FLIGHT LOG

FLIGHT:	**B033**	**DATE:** 22/07/2004	**OPERATOR:** Doug Anderson		**PAGE:** **1** of **1**
LOCATION:	West of the Azores		**PROJECT:**	ITOP – Interception of North American pollution, characterisation of background atmosphere and ENIVSAT validation.	

TIME (GMT)	**HEIGHT** (Flight Level or feet[''])	**RUN #**	**TEMP** (°C)	**DEW POINT** (°C)	**PUMP Volts**	**VOL. Flow** (l/min)	**LAMP Volts**	**Vis. Lamp Output**	**Instant F/l**	**Remarks**
10:24:08	GROUND	-	-	-	-	-	-	-	-	Flight # set
10:24:45	Ground	-	-	-	-	-	-	-	-	Lamp lighting test – 5 secs on 6.0
10:54:45	FL050	-	-	-	-	-	-	-	-	Air sample pipes opened
10:55:33	FL050	-	-	-	-	-	-	-	-	Lamp lit
10:56:45	FL050	-	-	6.9	-	-	-	-	-	Pump to 4.0 by mistake and off again straight away + cal pump on
12:10:30	FL156	P1	0.15	-19	4.0	1.87	0.4			Pump on as DP fell
13:06:20	FL080	P2.1	11	-8.3		0.08	0.41			Pump off
14:10:10	FL120			-11						Pump on
14:10/;35	FL121			-6						Pump off
14:22:00	FL133		4.36	-16						Pump on. Brief drop of DP to –6.3 but straight back below –10 again
14:59:50	FL129		5	-6						Pump off
15:10:50	FL090									Lamp off as DP too low and unlikely to return below –10
16:06:07	Ground									Shut down

Flight Manager's In-Flight Log

Flight No B...033.. Date ..22/07/2004 Page ..1.. of .....

Video Tapes
V8
No.
Ends
FFC / RFC / DFC / UFC

	GPS	INU
Lat	38 31.26 N	38 31.26 N
Long	28 42.98 W	28 43.00 W
Time	10:38:49	10:38:00
Status		

DRS	☑
HORACE	☑
SATCOM	☑

GMT	EVM	Height	QNH	Hdg	TAT	DP	DI Htr	Wind/ Sea st.
10 35 20								
10 44 37		TAXI,	PSAP	flow off				
10 45 20		ASPs	closed					
10 51 30		T/O						
10 57 56		J-W	cals	complete				
11 27 00		Cabin	temp	+ 26°C	24% RH			(on top of HORACE)
11 37 00		— " —		+ 24.6°C	21% RH			
11 39 00		Videos	recording					
11 48 00		Cabin	temp	+ 24.1°C	21%	RH		
11 58 00		SATCom	call,	CCM → DFL				
12 03 00		Cabin	temp	+ 23.4°C	21%	RH		
~~12 03 40~~		~~end of Tst~~						
12 19 20		Cabin	temp	+ 21.6°C	14%	RH		
12 27 35		TWC	reset					
12 28 50		TWC	source	ready				
12 35 00		Cabin	temp	+ 23.6°C	8.4%	RH		
12 42 00		— " —		+ 20.8°C	7.7%	RH		
12 53 00		— " —		19.7°C	6.5%	RH		
13 00 00		SATCom	call,	CCM → DFL				
13 15 00		Cabin	temp	+ 21.1°C	22.4%	RH		
13 22 00		EVM	ship plume					
13 41 19		PSAP	flow off					
13 46 20		PSAP	flow on					
14 15 00		Cabin	temp	+ 22.3°C	25%	RH		
14 33 40		Cabin	temp	+ 20.4°C	10.8%	RH		
15 09 10		Cabin	temp	+ 20.2°C	21.2%	RH		
15 42 00		Cabin	temp	+ 21.7°C	24.3%	RH		
16 00 00		PSAP	flow off					
16 01 26		LAND	Horta					
16 05 25	GPS	final posn:	38°31.26N	28 42.98 W				

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16 06 00 INV final posn: 38°30.70N 28 44.93 W

Flight Manager's Faults / Incidents Log

Flight No. B033 22/7/2004

Instruments

No Radalt signal

G.E. breaker on Core Console Rear getting "sticky" and sometimes fails to make contact.

Printing of time series & XY scatter plots - scales are changed when a chart is printed.

Aircraft

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